Project ID : EEMS009

U.S. DEPARTMENT OF ENERGY

SMARTMOBILITY

Systems and Modeling for Accelerated Research in Transportation

Energy Assessment of Automated Mobility Districts

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2017 ANNUAL MERIT REVIEW

JUNE 8, 2017

Argonne NATIONAL LABORATORY | INL Idaho National Laboratory | BERKELEY LAB | OAK RIDGE National Laboratory | NREL NATIONAL RENEWABLE ENERGY LABORATORY

Overview

Timeline

- Project start date: 10/1/2016
- Project end date: 9/30/2019
- Percent complete: 15%

Budget

- Total project funding
  - DOE share: $870K FY17-19
  - Contractor share: 0K
- Funding received in FY 2016: $0
- Funding for FY 2017: $290K

Barriers

- Computational models, design, and simulation methodologies
- Constant advances in technology

Partners

- Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Laboratory Consortium
  - NREL: National Renewable Energy Lab
  - LANL: Los Alamos National Laboratory
- Collaborating Universities
  - Texas Southern University
  - University of Central Florida

Relevance: How to evaluate energy and environmental impacts of SMART-enabled mobility district

Objectives

- Develop modeling capabilities for the VTO to estimate energy and environmental effects of Automated Mobility Districts (AMDs).

– Directly address critical question of “Energy impacts of Automated Mobility Districts” under Urban Science pillar.

– The modeling framework developed in this task can also be used for:

- Urban case studies
- Supporting effective policies and best practices
- U.S. Department of Transportation (DOT) Smart Cities.

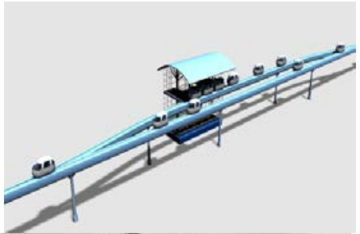
Milestones

Month/Year	Description of Milestone or Go/No-Go Decision	Status
March 2017	White paper, "Initial Assessment and Modeling Framework Development for Automated Mobility Districts," includes literature review of AMDs, submitted to ITS World Congress	Complete
June 2017	Identify early adopter stakeholders for cooperative agreement/collaboration to model impacts of AMD	On Schedule
September 2017	Develop a modeling approach architecture for AMD impact, and initiate modeling activity with stakeholder(s)	On Schedule

Approach (1)

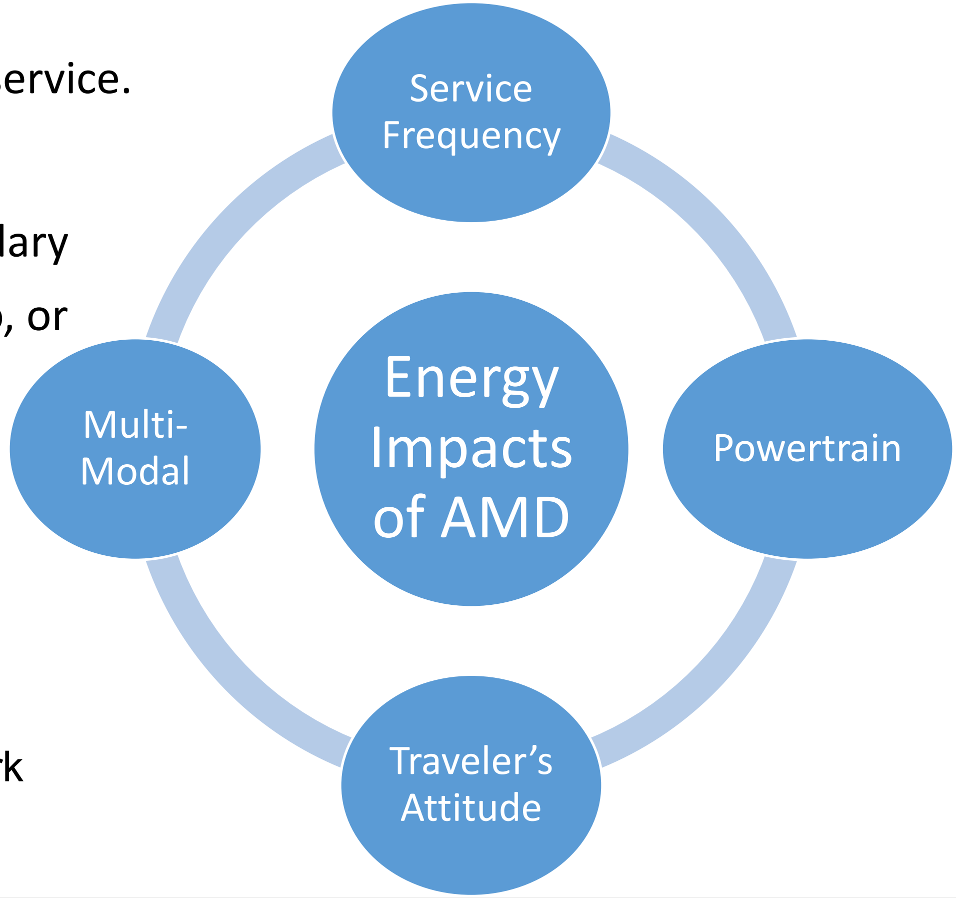
Automated Mobility District **(AMD)** is a term used to describe a campus-size implementation of automated vehicle technology to realize the benefits of fully automated vehicle mobility service.

- Fully automated and driverless vehicles
- Service is confined to a geographic boundary
- Mobility within the district is restricted to, or dominated by, automated vehicles.



On a captive guideway

On an existing road network

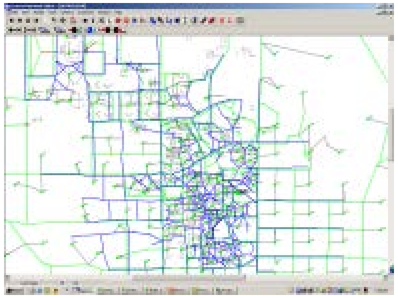


Approach (2)

- Build on existing AMD analysis
  - NREL authored IEEE Conference paper (Chen et al., 2015), an analysis of proposed automated mobility system on a university campus.
- Perform extensive literature and practice search
  - Mobility impact analysis
  - Automotive and automated transit disciplines.
- Develop and validate modeling framework
  - Assess mobility/energy impacts of AMDs.
- Exercise the model with partners either implementing AMDs, or seriously considering
- Produce case studies replicable/transferable to other proposed sights.

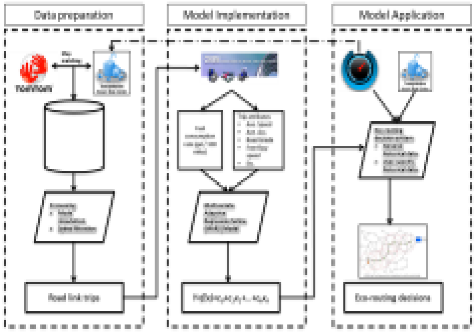
Technical Accomplishments and Progress (1)

Building on foundational work, Chen et al. (2015) was one of the first studies to evaluate energy impacts of AMDs.



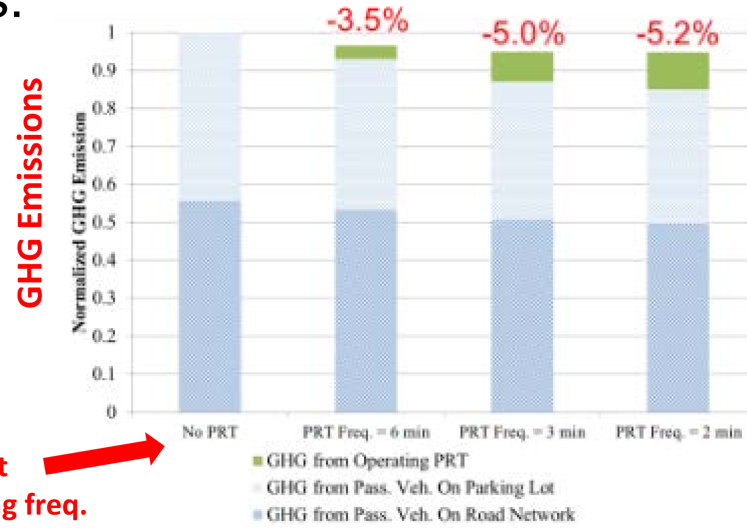
Mobility Analysis

- Travel mode choice
- Sidewalk activity
- Parking lot movements



Energy Analysis

- Powertrain/Fuel Efficiency
- AMD Service Frequency



Different operating freq.

System induces more travel, but at less energy.

System reduces energy/GHG emission between 3.5% to 8.2%.

Amount of reduction dependent on:

- **Fleet characteristics of AMD**
- **Amount of ride sharing**
- **Service frequency.**

Chen, Y., **Young, S.**, Qi, X, **Gonder, J.**, 2015. “Estimate of fuel consumption and GHG emission impact from an automated mobility district.” *IEEE International Conference on Connected Vehicles and Expo (ICCVE)*, November 2015, Shenzhen, China.

Technical Accomplishments and Progress (2)

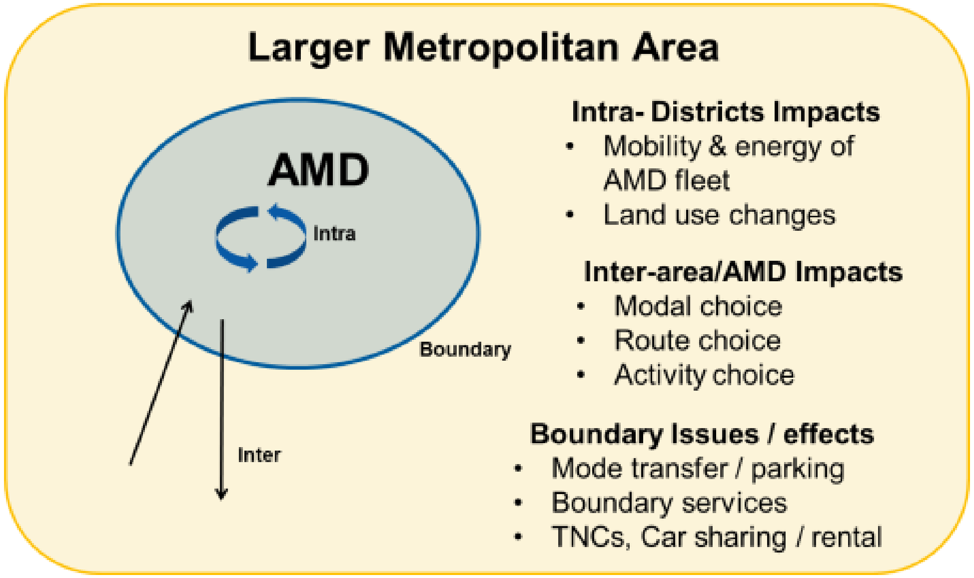
Reviewed related literature on AMD topics

Research	Study	Benefits	Downside
Kornhauser et al. (2013)	Autonomous taxis (aTaxis) and ridesharing potential in New Jersey	N/A	N/A
Burns et al. (2013)	Three case studies at Ann Arbor, Michigan, Babcock ranch, Florida, and Manhattan, New York	• Lower trip cost • Energy efficiency increase • Emission reduction	N/A
Fagnant and Kockelman (2014)	Mobility and environmental benefits of shared autonomous vehicles (SAV)	• Tremendous energy and emission savings with electric vehicles (EVs).	• Additional travel distance
Fagnant and Kockelman (2015)	Traffic simulation of a 12-mile by 24-mile region in downtown Austin	• Emission reduction • Cold-start emission reduction	• Additional travel distance
Fagnant and Kockelman (2016)	Introducing ridesharing to SAVs	• Total service time and travel cost fall • Reduce excess VMT • 19% annual return on SAV investment	N/A

Technical Accomplishments and Progress (3)

AMD Implementation, Past and Present

- Airports
- University campuses
- Urban centers
- Business campuses
- Military bases



Movement challenges of AMDs:
- Amount and proximity of parking
- Effective intra-campus circulation
- Pedestrian-vehicle conflict and congestion
- Efficient multi-modal access

PRT @ Morgantown, WV

Technical Accomplishments and Progress (4)

Assessing current modeling tools for their suitability of AMDs*

Tools	Trip Generation Modeling		Simulation Modeling		
	Trip-based	Activity-based	Multi-Modes	Open Source	Resolution
VISUM	X	X	X		Microscopic
DynusT	X		X		Macroscopic
MATSim		X	X	X	Microscopic
ALPS	X		X		Microscopic
QRS II	X		X		Macroscopic

* Additional tools are being evaluated as well, e.g., Polaris.

Collaboration and Coordination

- SMART Mobility Consortium Laboratories: NREL & LANL
- SMART Mobility Pillars: Advanced Fueling Infrastructure, Idaho National Laboratory (INL)
- Potential AMD Collaborators:
  - Texas Southern University
  - Kimley-Horn & Associates (ALPS)
  - Babcock Ranch Development
    - Kitson & Associates
    - Transdev
    - University of Central Florida
  - **Smart Columbus**
  - **Jacksonville, Florida**
  - **Contra Costa, Bishop Ranch**
  - **Military Bases**
- University of California Riverside
  - Vehicle-level, energy impacts modeling based on travel speed
- Advanced Transit Association (ATRA)

Response to Previous Year Reviewers' Comments

- This is a new project under the Energy Efficient Mobility Systems (EEMS) initiative. This project was not reviewed last year.

Remaining Challenges and Barriers

- Virtually no AMD study is based on data from actual field implementation of automated vehicles
- Existing literature is on primary automated transit systems (dedicated guideways) and typically an internal assessment, not holistic assessment
- There is limited literature (if any) to understand the impact of AMDs on travel behavior
- No established simulation tools for AMD impact analysis exist.
  - Requires multi-network simulation (rode, pedestrian, transit, parking, and AMD)
  - Most tools focus on single mode, simplify others – though some previous art in automated people movers may apply.

Proposed Future Research

- FY17 – Remaining
  - Identify and select collaboration opportunities for AMD deployment
  - Continue exploring tools and models
    - MATSim/ALPS/QRS II/others
  - Develop modeling framework for AMDs
    - Establish requirements
  - Initiate modeling for selected partner.
- FY18
  - Collect travel survey as well as operational data from the chosen partnership for AMD deployment
  - Use data to calibrate/validate model
  - Refine modeling framework (travel simulation and energy analysis) to assess the mobility and energy impacts of AMD transferable to other deployments (may spill into FY19).
- FY19
  - Generalize to AMD modeling toolkit.

Any proposed future work is subject to change based on funding levels.

Summary

- AMD research, under SMART Mobility Urban Science, anticipates early deployments of fully automated vehicles in geographically constrained areas as a public mobility service
- Objective is to develop modeling capabilities for VTO to estimate energy, emission, and mobility impacts of AMDs
- Initial white paper analysis includes:
  - Literature review
  - Mobility and energy assessment perspectives: inter-district, intra-district, and boundary effects perspectives
  - Types of AMD deployment environments
  - Initial assessment of available modeling tools, gap analysis.
- Main FY17 product is an integrated simulation and analysis framework to be implemented with stakeholders deploying or planning to deploy AMDs.

QUESTIONS?